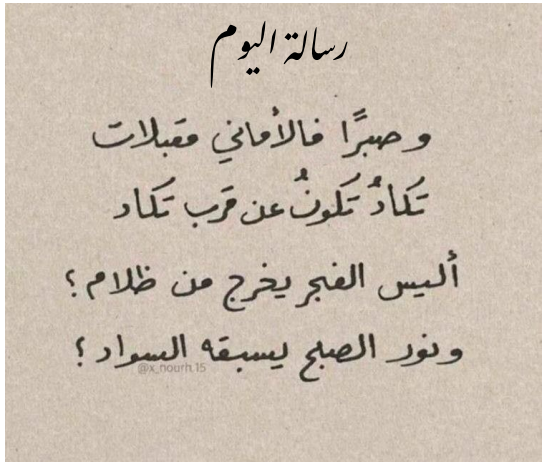
Sterilization and Disinfection



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1- what's the sterilization ?
2- what does it include ?
3- what does it used for ?

Key Terminology - I

- **Sterilization** التعقيم:
  - a- Removal or b- destruction of ALL forms of microbial life, including endospores → 100% killing
  - Includes bacteria (1), spores (2), fungi (3), viruses (4), and prions (5) ⇐ جثون البقر ← protein which make folding of other proteins.
  - Used for: surgical instruments (1), implants (2), parenteral fluids (3)

1- Describe the mechanism of it?
2- what does it used for?
3- what're the levels of it?

Key Terminology - II

- **Disinfection:** تطهير ⇒ Not effective on spores. بكتيريا
  - Destruction of vegetative pathogens on **inanimate objects**
  - Elimination of most pathogenic organisms
  - Does not necessarily kill bacterial spores
  - Three levels:
    - High-level: All microbes (including bacterial spores) → only this level kill spores.
    - Intermediate-level: Mycobacteria, viruses, fungi (but not sporocidal)
    - Low-level: A wide range of activity against microorganisms but no sporocidal or tuberculocidal activity
- **Antisepsis:**
  - Application of antimicrobial substances to **living tissue**
  - Examples:
    - a- Surgical hand scrub
    - b- Preoperative skin preparation
    - c- Wound cleansing

NoTe:-
-> Bactericidal :- Kill bacteria with the absence of host defense
-> Bacteriostatic :- inhabit growth of bacteria with presence of host defense.

1- what're the classification of medical materials ?

2- what does each material used for ? what's the level degree of disinfection for each one ?

Medical materials

- Medical materials into three device classifications
  1. Critical materials → materials that invade sterile tissues → are most likely to produce infection if contaminated, and they require sterilization → specially in cardic catheterization → entring to vascular system → so the material has to be highly disinfection
  2. Semicritical materials → materials that come into contact with mucous membranes → require high-level disinfection agents
  3. Noncritical materials → require intermediate-level to low-level disinfection before contact with intact skin.
- High-level disinfectants have activity against bacterial endospores,
- Intermediate-level disinfectants have tuberculocidal activity but not sporicidal activity.
- Low-level disinfectants have a wide range of activity against microorganisms but do not demonstrate sporicidal or tuberculocidal activity.

Mention the

Factors That Influence the Degree of Killing ?!

1. Types of organisms → most resistance :- prions.
   → least " :- Lipid viruses.
2. Number of organisms
3. Concentration of disinfecting agent ⇒ just make sure to be with the optimal range.
   ⇒ Not nessecary to have a high concentration for good result.
4. Presence of organic material (e.g., serum, blood)
5. Nature of surface to be disinfected
6. Contact time
7. Temperature → excessive high temprature → reduced the disinfection.
8. pH
9. Biofilms → a protective feature (which) bacteria produced against disinfectant agents
10. Compatibility of disinfectants and sterilants

Factors: **1-** Types of organisms

Microbial Resistance Hierarchy مهم

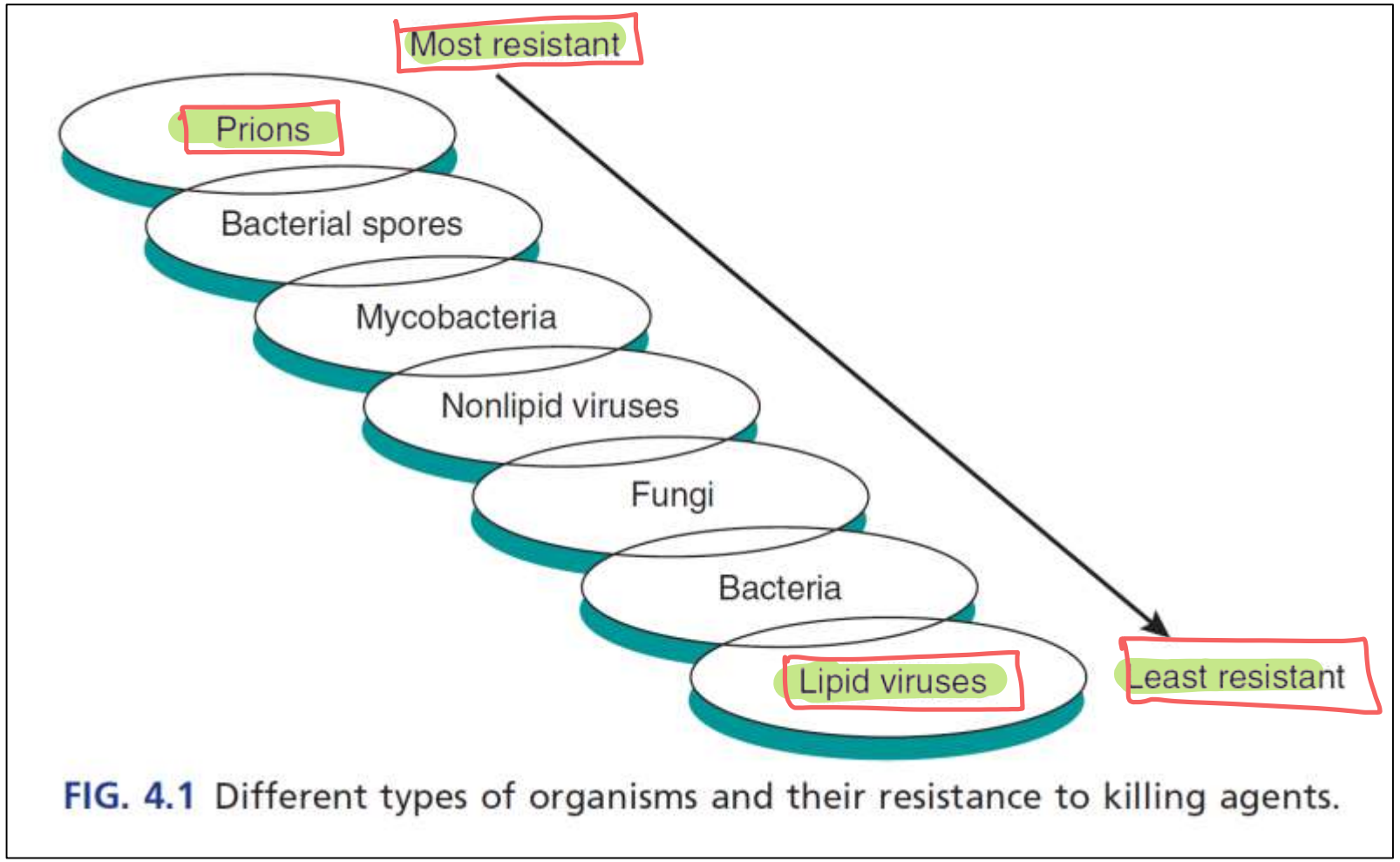
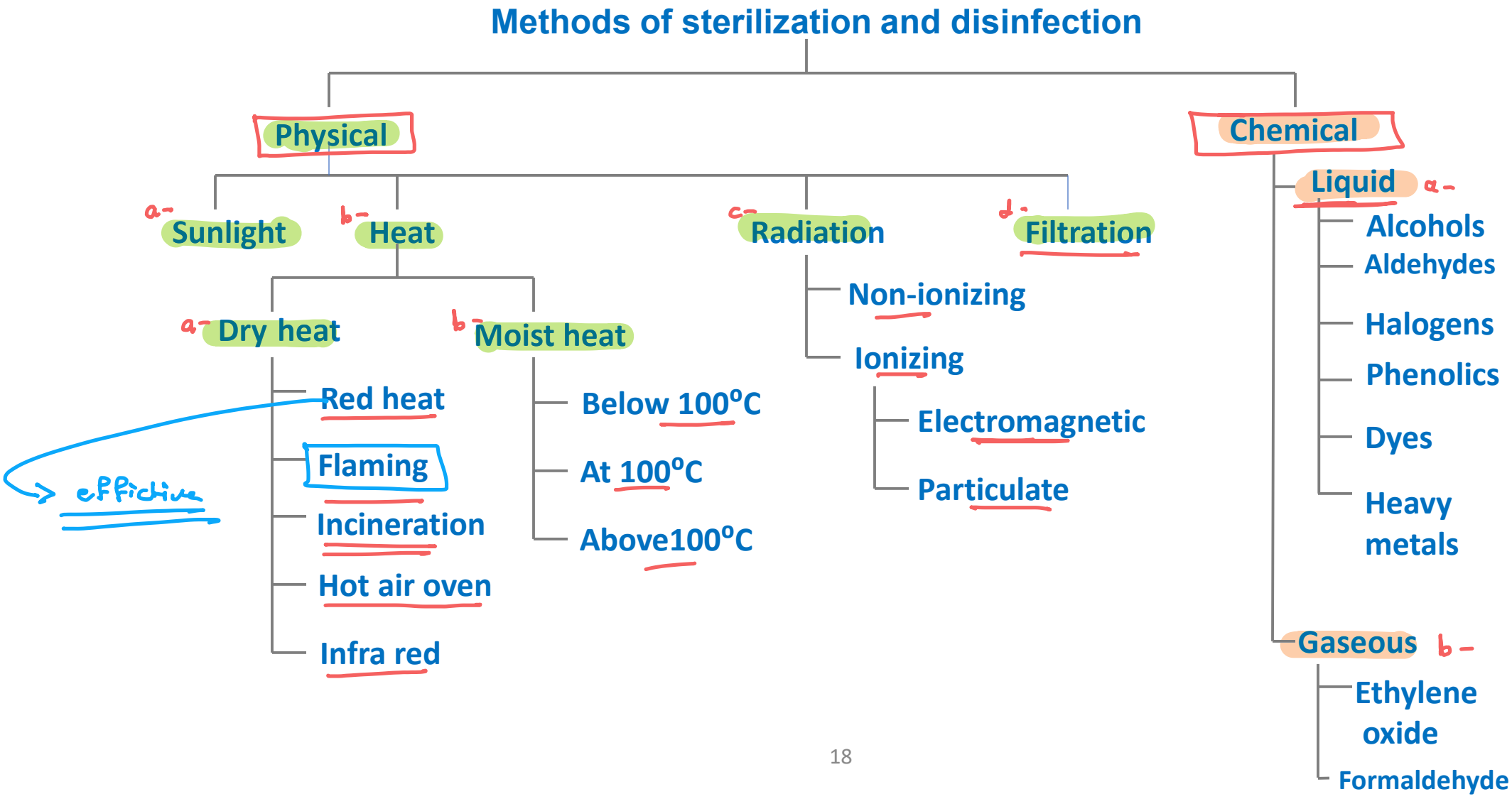


FIG. 4.1 Different types of organisms and their resistance to killing agents.

Methods of Sterilization



Physical methods
Dry Heat Sterilization

1- what's the function of it?
2- what are the Types of it?

- Death of micro-organism is by destructive oxidation effects of essential cell constituents especially protein denaturation.

heat with fan to distribute heatness (dry)

Types

Red Heat

Flaming

Incineration

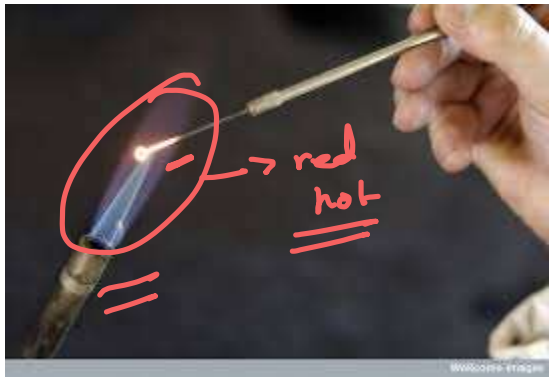
- High pressure
- High temperature.

Hot air oven

Physical methods
Dry Heat Sterilization - Red heat

1- what does it used for ?
2- Describe the mechanism of sterilization ?
3- what's special about this method ?

- Articles such as bacteriological loops, tips of forceps, and spatulas are sterilized by holding them in Bunsen flame till they become red hot. This method is limited to those articles that can be heated to redness in flame.

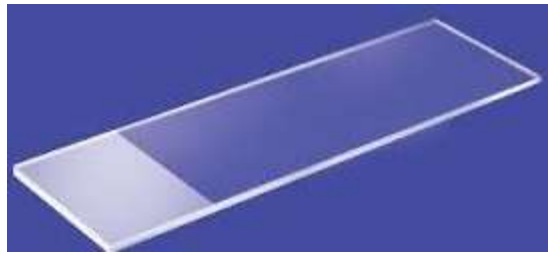


Physical methods
Dry Heat Sterilization - Flaming

1- Describe the mechanism of flaming?
2- what does it used for?

- This is direct exposure of materials to naked flame. Inoculation loop or Wire, the tip of Forceps and spatulas are held in a Bunsen flame till they are red hot.

scalpels



glass slides

mouth of test tubes

Flasks

Direct exposure

Physical methods
Dry Heat Sterilization – Incineration

- Excellent method of destroying materials such as contaminated cloth, animal carcasses and pathological materials, surgical dressings, sharp needles and other clinical waste at high temperatures (1500°C).

Physical methods
Moist heat

1- what's special about it?
2- what's the machanizem of killing?

- It is a more effective method compared to dry heat. (*)
- Mechanism of killing: proteins coagulation. ✓
- Forms:
  - below 100°C: Pasteurization.
  - at 100°C: Boiling.
  - above 100°C: Autoclave.

↓ 100 ...
— 100 ..
↑ 100 ...

→ it has a storage tank, and has many programmes
→ it provide a ↑ pressure, so ↑ Temprature is obtained.

Physical methods

Moist heat - Below 100°C

- what does it include ?
- what does the pasteurization used for? what's the type ?
- what's the machanirem of vaccine bath? what does it killed ?

A. Pasteurization

- Do not kill spores +
- Employed in the food and dairy industry.
- Types:
  - Holder method at 63°C for 30 minutes.
  - Flash method at 72°C for 15 minutes rapid cooling to 13°C.

B. Vaccine bath:

- The contaminating bacteria in a vaccine preparation can be inactivated by heating **in a water bath at 60°C for one hour**.
- Only vegetative bacteria are killed and spores survive.

Physical methods

Moist heat - at 100°C (Boiling)

- kills most microorganisms in 10 min. at 100C except spores and certain bacterial toxin.
- Tyndallization: an exposure of 100°C for 20 minutes on 3 successive days; sporicidal

Physical methods
Moist heat - Above 100°C

- By using autoclave
- Destroy **ALL** microorganisms and their spores
  - Steam under 1 atm of pressure, at 121°C, 15 minutes of exposure in autoclaves
  - Destroy ALL microorganisms **(including prions)** and their spores
    - Using longer times: 135°C for at least 1 hour under 2 atm
- **Application:** the sterilization method of choice for heat-stable objects

Controls used in sterilization using Autoclaves

The efficiency of an autoclave should be tested by ؟!

1. Temperature recorder(thermometer) .①
2. Pressure recorder(barometer) ②
3. Browne's tubes: **are glass tubes that contain heat-sensitive dyes. These change color after sufficient time at the desired temperature.**
   - Red to green means complete sterilization.
   - Red to brown means incomplete sterilization.

تغير اللون يدل على الوصول إلى درجة الحرارة المطلوبة.

— + — = Complete sterilization.

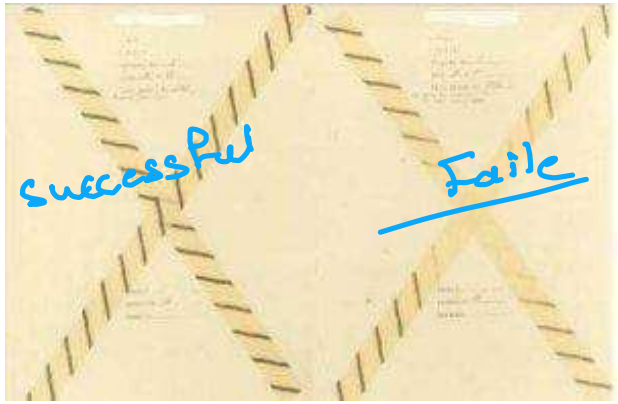
— + — = incomplete - -

→ Bowie's tube

Red to **green**

Controls used in sterilization using Autoclaves

4. Spore indicator (biological control): They are biological indicators including spores of Bacillus stearothermophilus. If grows after sterilization, this means incomplete sterilization.
5. Bowie Dick tape: before heat exposure, the tape is uniformly buff in color. After adequate heating, the tape develops dark brown stripes.



The color-changing indicator of tape is usually lead carbonate based, which decomposes to lead(II) oxide

Physical methods
Liquid filtration

- Filtration methods may be used with both liquid and air.
- The membrane filters are composed of plastic polymers or cellulose esters containing pores of a certain size
- The liquid is pulled (vacuum) or pushed (pressure) through the filter matrix.
  - Organisms larger than the size of the pores are retained.
- **Pore size of:**
  - 0.45 and 0.80 µm: most bacteria, yeasts, and molds
  - 0.22 µm: for critical sterilizing, e.g. parenteral solutions
  - 0.01 µm: for retaining small viruses
- **Application:** parenteral solutions (serum), vitamins, vaccines and antibiotic solutions

Physical methods
Air filtration

- Filtration of air is accomplished with the use of high-efficiency particulate air (HEPA) filters
  - HEPA filters are able to remove microorganisms larger than 0.3 µm and are used in laboratory hoods and in rooms of immunocompromised patients.

Physical methods
Radiation

- Radiation has various effects on cells, depending on its wavelength, intensity, and duration. Radiation that kills microorganisms (sterilizing radiation) is of two types:
    1. ionizing
    2. nonionizing.

Physical methods
Radiation

A. Ionizing radiation

- gamma rays or electron beams
- short wavelength and high energy

Application: for the medical industry: the sterilization of disposable supplies (syringes, bandages, catheters and gloves), and heat-sensitive pharmaceuticals,

B. Non-ionizing

- Rays of wavelength longer than the visible light are non-ionizing
- in the form of **ultraviolet rays (UV)(280-200 nm)**
- long wavelength and low energy
- Radiation is not very penetrating
- the use is limited

Application: disinfect smooth surfaces with ultraviolet lamps and to reduce airborne pathogens (hospital wards, operation theatres, virus laboratories)

Chemical methods
1- Alcohols

→ Alcohols → 100% → This not helpful because we need water for denaturation.

- **Ethanol 70%, isopropanol 70%, propanol 60%**
- Inactivate microorganisms by denaturing proteins
- Wide spectrum against **bacteria and fungi but not sporocidal!**
- **Tuberculocidal and virucidal for most viruses (15 min.)**
- Alcohols may be contaminated with spores –should be filtered through a 0.22 µm filter
- The most effective concentrations are between 60%-90% (water is needed in chemical reactions → because denaturation requires water)
- **Application:** surgical and hygienic disinfection of the skin and hands

Chemical methods
2- Aldehydes

- This is in form of water soluble gas that is lethal to all kinds of micro-organisms and spores.
- **Application:** disinfection of surfaces and objects (plastic and rubber items)
- The sterilizer of choice for heat-sensitive medical equipment

Chemical methods
3- Halogens: (iodine, and their derivatives)

<u>Iodine (2 forms)</u>

- **tincture (alcohol and iodine)**
- **Iodophors or called povidone-iodine (iodine and surfactants)**
- **bactericidal, not sporocidal**
- less irritant than pure iodine

- **Application: as antiseptics, disinfection of skin and small wounds**

Chemical methods
3- Halogens: (iodine, and their derivatives)

Phenols

- Denaturate proteins
- **Broad-spectrum, but not sporocidal, not virucidal**

- **Application: widely used, disinfection of hospital, institutional, and household environment (soaps)**